CHLORINATED DIBENZO-P-DIOXINS

AND

CHLORINATED DIBENZO-P-FURANS

IN

SELECTED DRINKING WATER SUPPLIES IN ONTARIO

December 1983

Ministry of the Environment
Ontario

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TABLE OF CONTENTS

APPENDICES

CHLORINATED DIBENZO-P-DIOXINS AND CHLORINATED DIBENZOFURANS IN SELECTED DRINKING WATER SUPPLIES IN ONTARIO

The Ontario Ministry of the Environment Dioxin Laboratory was established in 1980 to address the emerging problem of polychlorinated dibenzo-p-dioxins (PCDD) in the environment. These compounds first came into prominence as impurities in the manufacture of chlorinated phenols, an important group of industrial chemicals used in the production of a variety of substances, especially certain herbicides such as 2,4,5T and 2,4, D. It was later discovered that PCDD were also present in the emissions from municipal incinerators in Ontario (1). A report by the Dow Chemical Company claimed that PCDD were in fact associated with the chemistry of combustion, and that trace levels were detected in such diverse sources as soot from fireplaces, ash from cigarettes and charcoal-broiled meat (2). Not all of these findings have been substantiated by others. However, recent findings of small levels of PCDD in human adipose tissue indicated that these compounds are more widespread in the environment than previously suspected (3).

Due to its high toxicity in laboratory animal studies, most attention has been focused on 2,3,7,8-tetrachlorodibenzo-p-dioxin (2,3,7,8-TCDD) one of 75 possible PCDD compounds, although some of the other PCDD compounds have also shown high toxicities. In addition, some members of a group of 135 structurally similar compounds, the polychlorinated dibenzofurans (PCDF), were shown to have toxicities similar to those of corresponding PCDD compounds. A basic and detailed discussion of PCDD/PCDF properties and chemistry was presented in a monograph by the National Research Council (4).

In 1981, evidence that dioxin was present in Lake Ontario was revealed when low levels of 2,3,7,8-TCDD were detected in some fish (5), (6). The point source of this dioxin was thought to be chemical dump sites on the Niagara River. Therefore, a monitoring program was initiated by the Ministry of the Environment to investigate the presence of 2,3,7,8-TCDD in Lake Ontario water. Initially, samples were collected in the Niagara area, and then the program was expanded to test waters in other areas of Lake Ontario. The analytical methods employed in 1980 gave a detection limit of 1 part-per-trillion (ppt) for 2,3,7,8-TCDD in a 1-litre water sample. Acquisition of more advanced instrumentation enabled this limit to be lowered to 0.25 ppt. At this improved detection limit, traces of TCDD were detected in 3 Niagara area single raw water samples (February 1983). No TCDD was detected in any of the treated samples. Extracts from both raw and treated water samples sent to Health and Welfare, Canada confirmed these findings.

A new survey was initiated in June 1983 to test selected Ontario drinking water sources for PCDD. The detection limit for this study was lowered to 0.010 ppt (10 parts per quadrillion ppq) by increasing the sample volume (12 litres). Since other dioxins and furans may be associated with TCDD, the entire range of PCDD and PCDF compounds from the tetra-through octachlorinated species, including all potentially toxic isomers, were monitored. Due to the ultra-trace nature of this work, an extensive quality control program, including strict sampling procedures, was developed and confirmation was sought from an outside laboratory (Health and Welfare). This report describes the analytical and sampling methods developed for this survey and presents the data obtained.

2. METHODS

2.1 Sampling

PCDD/PCDF analysis in drinking water is an expensive and sensitive procedure with measurements in the parts per quadrillion range (ppq). Effects of contamination or interference are therefore intensified. A standard sampling protocol was developed to assure consistent high quality samples. These protocols are highlighted below and detailed in Appendix I.

Water treatment plants sampled were chosen on the basis of population served and probability of exposure (Table 1). At each water plant both raw and treated samples were taken. The sampling system at the plants had to meet certain criteria before sampling could be initiated (Appendix I). Retention time between raw and treated sampling points was taken into account to assure sampling of the same block of water. Acceptance criteria for sampling was based on the stability of raw and treated water turbidities over the time of sampling.

Field blanks were part of the protocol in order to quality control the sampling procedure and environment in the field. Support chemistry samples were obtained to assure integrity of the sample and determine if the chemical profile was typical of the water quality generally encountered. Support data describing plant processes, operations and sampling site were recorded to further assure consistent quality of the samples and field blanks.

Actual water samples were taken as composites over three 15 minute intervals in order to obtain a representative sample. Strict protocols were observed during sampling . (Appendix I).

2.2 Analytical

Analysis of PCDD/PCDF at the 10 part per quadrillion level demands that very stringent quality controls be incorporated into the analytical procedure as well as the sampling procedure to ensure the validity of the data base. The quality assurance procedures, which are documented in detail in Appendix II are summarized below:

1. A dedicated, isolated laboratory was used for processing all water samples.

2. All glassware and reagents used in the sampling and analytical procedures were proven free of contamination.

3. An isotopically labelled 2,3,7,8-TCDD standard solution was added as an internal standard to each water sample. As this dioxin acts as an indication of the behaviour of all PCDD, the recovery of this standard after processing indicates the efficiency of the analytical procedure for all PCDD/PCDF.

4. Data acceptance was based on:

(i) All peaks detected during Gas Chromatography/Mass Spectrometry analysis had to satisfy the criteria detailed in Appendix II.

(ii) All sites were analysed in duplicate; validation of PCDD/PCDF peaks required detection in both replicate samples.

(iii) Duplicate samples from selected sites were sent to Health & Welfare, Canada. Data was considered valid if similar results were obtained in both duplicate M.O.E. or H & W samples.

(iv) Samples where obvious Gas Chromatography/Mass Spectrometry mass interfering signals existed were discarded.

Processing of samples included extensive chromatographic clean-up and analysis of the final extract by high resolution GC/low resolution (1,000) mass spectrometry. Confirmation of positive PCDD/PCDF was done using high resolution (12,000) mass spectrometry.

3. RESULTS AND DISCUSSION

3.1 Analytical Results

3.1.1 M.O.E. Data

The study entailed collecting samples from raw and treated drinking water representing 15 plants over 110 days from June to September, 1983. (Table I) (Lakeview was sampled twice). According to the criteria for data acceptance, data was valid for 14 of these plant sites. (Toronto Island samples did not meet the criteria for data acceptance documented on pg. 4).

PCDD/PCDF were not detected in any of the treated drinking waters at the 10 ppq detection limit. (Appendix III).

In 13 of the 15 raw water samples PCDD/PCDF were not detected. St. Catharines duplicate raw water samples had 46 and 33 ppq of octachlorodibenzo-p-dioxin (OCDD). Similar levels were observed in Lakeview duplicate samples with levels of 29 and 31 ppq OCDD in the raw water.

However, repeat of the Lakeview sampling six weeks later did not exhibit any PCDD/PCDF in the raw water.

Octachlorodioxin is the fully chlorinated (eight chlorines) form of dibenzodioxin. OCDD, the only isomer found, is known to be one of the least toxic of all dioxins and is generally associated with toxic levels one or more orders of magnitude lower than the level for 2,3,7,8-TCDD. (7).

Raw water data suggests that the Eastern Lake Erie - Western Lake Ontario portion of the Great Lakes is relatively free of PCDD/PCDF in ambient water used for water supply. Further, conventional drinking water treatment at the two locations where OCDD was detected in the raw water, appears to be an efficient barrier to the OCDD as it was not detected in the treated water.

No significant changes in chemistry support data collected over the raw and treated sampling periods at each plant were detected. (Appendix IV). Colour, however, was an exception since it varied in 6% of the samples. This variation could be attributed to colour's instability over time, along with variations due to analysis at low levels. General water quality at Lakeview and St. Catharines, therefore, remained constant throughout the sampling period. The presence of OCDD was not linked to of intermittent changes in water quality.

Comparison of 1983 chemical data with previously collected data, (1978-1980) revealed that water samples from each location were typical of the water quality generally encountered there. (8).

In future, chemical support data should include only turbidity, conductivity, hardness, alkalinity, pH and total residue. Consideration should also be given to PCB and chlorophenol analysis in the raw and treated duplicates as several PCDD congeners are known to be associated with chlorophenols and some PCDF are associated with PCB levels.

3.1.2 Health & Welfare Data

Health & Welfare, Canada was provided with duplicate samples for raw and treated water from Easterly and RC Harris and treated water from Oakville and Lakeview (July '83 sampling). High resolution mass spectrometric analysis of sample extracts for total TCDD, total TCDF and total P_5CDD confirmed M.O.E. analysis. This data is presented in Appendix III.

3.2 Relationship Between Turbidity and PCDD/PCDF

The hydrophobic nature of some PCDD would suggest that PCDD should be associated with the particulates in water, therefore, water low in particulates should also be low in PCDD. The limited data set confirms this with one exception. In 30 duplicate samples, 28 were shown to have PCDD below the detection limit and relatively low particulate levels as expressed by turbidity (Raw 0.75 - 5.0 formazine transparency units (F.T.U.), Treated 0.2 - 0.5 F.T.U.). Of the two samples containing OCDD, St. Catharines raw water had the highest turbidity encountered in the survey (7.0 F.T.U.). Lakeview raw water sampled in July was an exception since the OCDD detected was associated with a relatively low (1.5 F.T.U.) for raw water. Repeat sampling in September revealed an absence of OCDD in the raw water with a turbidity of 1.7 FTU. The fact that in both cases where OCDD was detected, it was in the raw and not in the corresponding treated sample, lends weight to the association of turbidity and dioxins.

In St. Catharines, samples were taken at the same time in light of the turbidity criteria (Appendix 1, section 1.3) while at Lakeview, the retention time between raw and treated sampling was observed. Hence, it is assumed that the same block of water was being sampled for the raw and treated water, consequently, in both cases, a treatment effect was being observed.

There are not enough data points to reach any statistically significant conclusion, but it is reasonable to suggest that low levels of turbidity are associated with PCDD/PCDF levels below the detection limit. The absence of PCDD/PCDF appears to be associated with turbidity levels less than 1 F.T.U. (Ontario Drinking Water Objectives) in the treated water.

3.3 Analytical Observations

A true estimate of the method reproducibility cannot be made solely on the basis of native PCDD/PCDF detected in duplicate samples, since only OCDD was detected in the raw waters of only 2 locations. For these samples, reproducibility between replicates was good.

Variation in the analytical procedures can be estimated by the variability in isotopically labelled TCDD recoveries. (Table 2). There is little difference between average recoveries and variance of recoveries for raw water, treated water and field blanks at a spiking level of 28 ppq. Horowitz has shown interlab variation to increase exponentially with decreasing concentration (9). The co-efficient of variation for PCDD/PCDF in the ppt range was at least an order of magnitude higher

than for pesticide residue analysis at ppm levels. Since the PCDD/PCDF analyses of waters reported here were conducted at concentrations one thousand times lower than ppt levels, the variations in spike recoveries shown in Table 2 are not unexpected. M.O.E. and Health & Welfare laboratories showed similar spike recoveries, and similar variance in recoveries.

Because some components of the total analytical variation can lead to high as well as low results, recoveries greater than 100% can be obtained. However, some recoveries were more than 150%, and reasons for these very high recoveries are not known. Studies are planned to investigate sources of this variation and adjustments will be made to the analytical procedure to minimize their effect.

The analytical and sampling procedures described are adequate for measurement of PCDD/PCDF, but are time consuming, laborious, delicate and expensive. To surmount these problems, a study of resin cartridge applicability for monitoring of PCDD/PCDF in water is currently being undertaken.

CONCLUSIONS

1. The sampling and analytical protocols developed for this project are sufficiently sensitive for the determination of PCDD/PCDF in raw and treated drinking water at the parts per quadrillion level.

2. For the 14 municipal water supplies tested in the Eastern Lake Erie - Western Lake Ontario basin including Toronto, (R.C. Harris, Easterly, R. L. Clark), St. Catharines, Welland, Niagara Falls, Fort Erie, Oakville, Burlington, Oshawa, Hamilton, Port Colborne, South Peel (Lakeview, Lorne Park):

   (i) no PCDD/PCDF were detected in treated drinking water at a detection limit of 10 ppq;

   (ii) generally no PCDD/PCDF were detected in raw water at a detection limit of 10 ppq with the exception of traces of a single low toxicity PCDD (OCDD) in St. Catharines raw water and in one Lakeview raw water sampling.

3. Where OCDD was detected in the raw water, conventional drinking water treatment processes appeared to remove the ultra-trace concentrations of octadioxins present in the raw water supplies.

4. In this limited data set, the absence of PCDD/PCDF appears to be associated with turbidity levels less than 1 F.T.U. (Ontario Drinking Water Objectives) in the treated water.

RECOMMENDATIONS

1. More rapid, rugged and less expensive procedures must be developed for purposes of monitoring water supplies.

2. Extremely strict quality assurance protocols, including replicate testing and external laboratory corroboration, should be incorporated into testing programs to ensure the integrity of the data base, especially when measurements in the parts per quadrillion range are undertaken.

3. More data needs to be obtained to ascertain what levels of dioxins and furans constitute background levels.

4. An acceptable level for PCDD/PCDF in drinking water should be developed and adopted as soon as possible.

5. In future, chemical support data should include only turbidity, conductivity, hardness, alkalinity, pH and total residue, chlorophenol and PCB levels.

FUTURE PROGRAM

Although the data from this survey show that PCDD/PCDF do not represent a health hazard in raw/treated drinking waters, the samples which were analysed represent a limited sampling.

Further work is required to:

1. investigate possible seasonal variations;
2. expand the data base to include other Ontario water treatment plants;
3. develop faster, simpler and less expensive field sampling/extraction procedures;
4. further define any relationship between turbidity and levels of PCDD/PCDF.

TABLE I

SAMPLING LOCATIONS AND SAMPLING DATES OF WATER TREATMENT PLANTS FOR DIOXIN/FURAN DRINKING WATER PROGRAM

	Location	Date Sampled
(1)	R. C. Harris (Toronto)	June 6, 1983
(2)	Easterly (Toronto)	June 9, 1983
(3)	St. Catharines	June 22, 1983
(4)	Welland	June 23, 1983
(5)	Niagara Falls	July 12, 1983
(6)	Fort Erie	July 12, 1983
(7)	Lakeview (South Peel)	July 25, 1983
(8)	Oakville	July 27, 1983
(9)	Burlington	August 9, 1983
(10)	Lorne Park (South Peel)	August 11, 1983
(11)	Oshawa	August 22, 1983
(12)	Hamilton	August 23, 1983
(13)	Lakeview (South Peel)	September 7, 1983
(14)	R. L. Clark (Toronto)	September 8, 1983
(15)	Toronto Island (Toronto)	September 15, 1983
(16)	Port Colborne	September 26, 1983

Fifteen separate sampling locations (Lakeview sampled twice, yielding 16 separate sampling events).

TABLE 2

VARIATION OF SPIKE RECOVERIES

IN EXTRACTED SAMPLES

	Number of Samples	Average Recovery(%)	Std. Dev.	Range of Recoveries(%)	Median Recovery(%)
Raw waters (Replicates A & B)	26	47	37	0 to 180	33
Treated waters (Replicates C & D)	26	78	70	7 to 300	55
Field Blanks (Raw & Treated)	26	67	45	15 to 190	52

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The co-operation of the administration and staff of the water treatment plants tested is gratefully acknowledged.

APPENDIX I

SAMPLING METHODS

1.1 Sampling Site

Samples for dioxin analysis were not taken under less than ideal sampling conditions. A sampling system had to meet the following criteria:

1. water was drawn from proper locations:

   raw - prior to any physical or chemical treatment

   treated - after completion of all physical and/or chemical treatment.

2. Sampling system piping and pumping material in contact with the sampled water was organically inert (no plastics except Teflon). for example, Teflon.

3. Sample tap outlet was located in a clean area of the plant which allowed adequate clearance under the tap and constant flow to waste.

1.2 Sample Containers

Two types of containers were used:

1. specially cleaned 4 litre brown glass bottle with a Teflon lined cap for water samples for dioxin analysis (section 2.2).

2. 1 litre glass bottle for support chemistry sample.

1.3 Sample Timing

Composite samples were collected for dioxin analysis with one quarter bottle being taken at 15 minute intervals over 45 minutes. Sampling was initiated at t = 1 (0 minutes) by filling all bottles one quarter full. This was repeated for t = 2 (15 minutes), t = 3 (30 minutes) and t = 4 (45 minutes). (Figures 1 and 2). Retention time was considered in order to assure sampling of the same block of water throughout the treatment process and was determined as follows:

$$\frac{\text{Volume of plant } (m^3)}{\text{flow } (m^3/\text{min.})} = \text{retention time (min.)}$$

Where both raw water turbidity and treated water turbidity showed fairly constant levels over the previous two retention times (no more than 25% change in raw or 50% change in the treated) samples were taken simultaneously. The data documenting this was recorded on the field sheets (Figures 3 and 4).

1.4 Field Blanks

Field blanks, used for quality assurance, consisted of transporting 8-4 litre proven clean brown bottles (4 raw, 4 treated) of proven distilled/deionized water from the laboratory to the field. At each 15 minute sampling interval one bottle of water was decanted into each of three dioxin sample bottles (FB-1, FB-2, FB-3) and one support chemistry bottle (FB-chem) in 1/4 portions (Figures 1 and 2). Excess water present after allocations was disposed of and the next portion taken from a fresh bottle. Handling procedures, re-capping and uncapping were similar to those used for dioxin samples and the decanting was done in close proximity (1-2 m) to the sample site.

1.5 General Chemistry

Support data for general water quality parameters such as hardness, alkalinity, pH, colour, turbidity were collected for each sample in order to check the integrity of the sample over the actual sampling time (Appendix IV). Comparison of this data with previous plant data confirmed that the sample was or was not typical of the water quality generally encountered.

1.6 Sampling Procedure

Sampling, at one location, for example a raw water tap, consisted of four parts:

1. three bottles for dioxin analyses (A-1, A-2, A-3);

2. a duplicate set (B-1, B-2, B-3);

3. field blanks, utilizing distilled water from the Dioxin Laboratory (AB-FB-1, AB-FB-2, AB-FB-3);

4. support chemistry (AB-1 chem, AB-2 chem, AB-3 chem, AB-4 chem, and AB-FB chem).

For the first sampling, the following sequence was used:

1. Quarter fill A-1, A-2, A-3;

2. Fill AB-1 chem;

3. Quarter fill B-1, B-2 and B-3;

4. Quarter fill with distilled water from the laboratory, AB-FB-1, AB-FB-2 and AB-FB-3; and

5. Quarter fill with distilled water from the laboratory, AB-FB chem (Figures 1 and 2).

A similar sequence was used for the three remaining sampling times with support chemistry bottle AB-2 chem, AB-3 chem and AB-4 chem being filled sequentially.

Treated water sampling was conducted in the same manner, however, labelling was as follows:

Part 1 - C-1, C-2, C-3;

Part 2 - D-1, D-2, D-3;

Part 3 - CD-FB-1, CD-FB-2, CD-FB-3,

Part 4 - CD-1 chem, CD-2 chem, CD-3 chem, CD-4 chem and CD-FB chem.

1.7 Shipping and Handling

Samples were transported to the laboratory as quickly as possible and kept cool ($5^{o}C$) during shipment. Samples arriving more than 48 hours after sampling or in a warm state were discarded by laboratory personnel.

Extraction was initiated within 72 hours of arrival at the laboratory. A maximum of 5 days was allowed between arrival at the laboratory and completion of extraction.

1.8 Support Data

Support data taken at each plant included the following:

1. the plant description and operation at time of sampling (flow rates retention times, chemicals being added, plant turbidities);
2. bottle lot numbers for all "dioxin" and field blank;
3. times and other details of sampling; and
4. turbidity of chemistry samples AB-1-4 chem and CD-1-4 chem, determined in the field.

1.9 Acceptance Criteria

Only samples, which were representative of the general water quality were accepted for analysis. Acceptance criteria was based on individual sample turbidities. If the turbidities taken during sampling varied by more than 25% for the raw or 50% for the treated, turbidity behaviour was examined. If the variation was considered normal, the sample was retained. If the variation suggested an unusual occurrence during sampling, the sample was discarded.

1.10 General Considerations

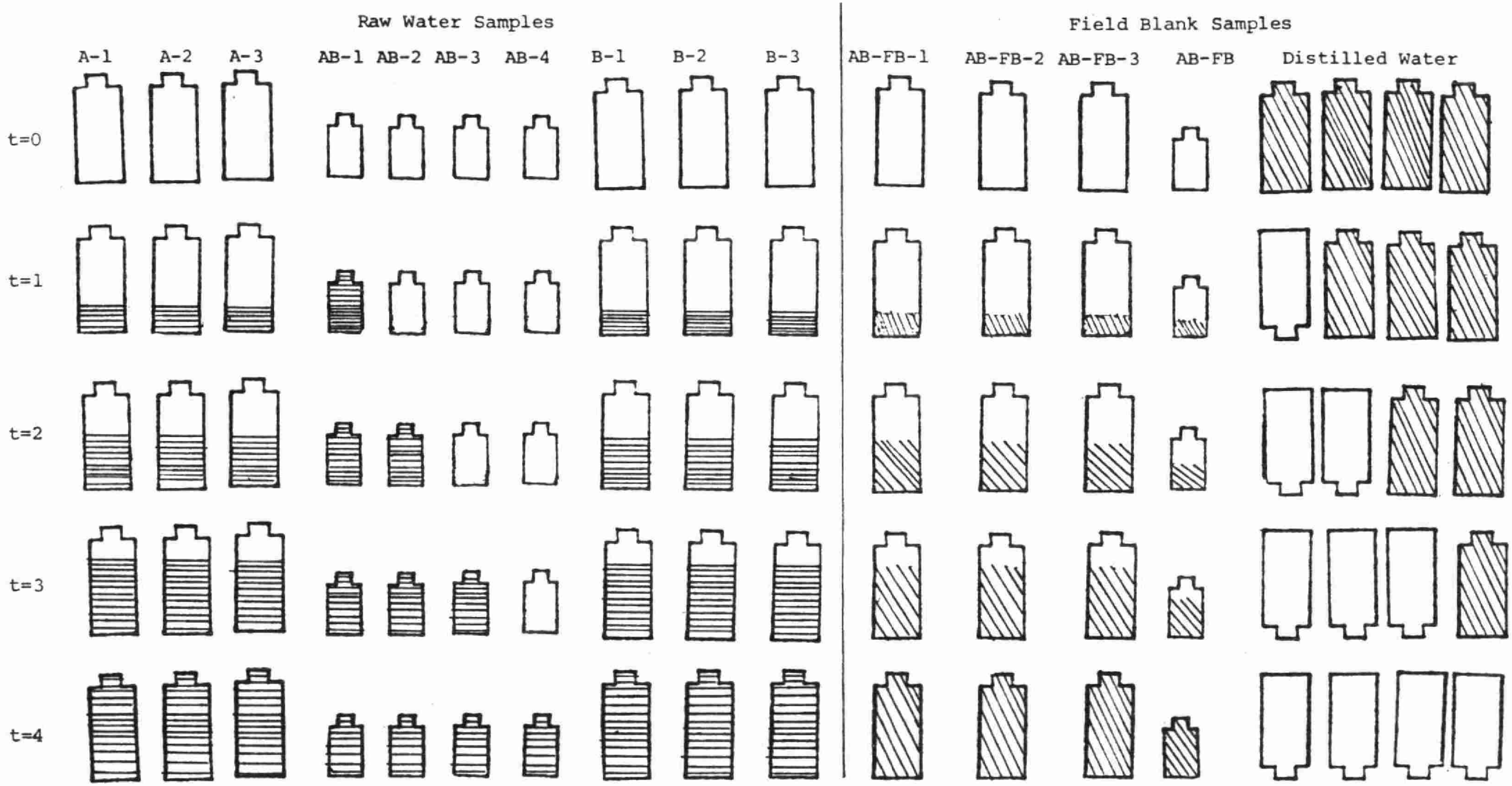
Field personnel wore latex gloves while sampling to avoid contamination of the sample. Care was taken not to touch the inside of the cap or bottle. Gloves were exchanged with a new pair prior to each sampling interval.

No smoking in the sampling area was allowed.

The precleaned bottle was not rinsed prior to filling. A one inch head-space was left at the top of the bottle which allowed for mixing in the laboratory.

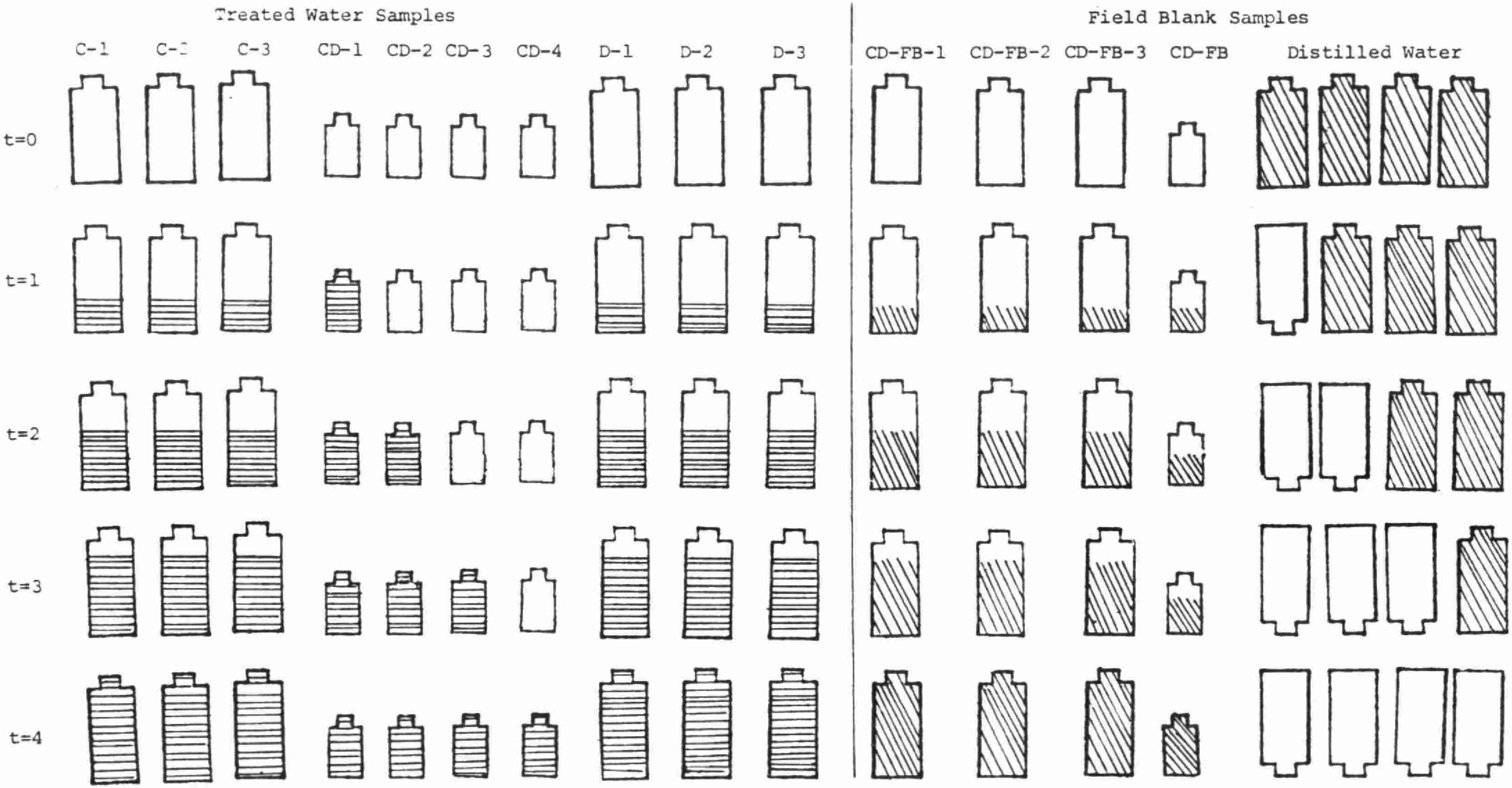
Prior to sampling at a tap, screens, aerators and/or tubing were removed. The tap was allowed to run at a constant rate for a period of 10 minutes prior to taking the sample and the tap was not adjusted during sampling as this could have caused large changes in the water quality. No part of the tap touched the bottle during filling. The bottle cap was held face down to prevent any possible contamination.

Figure I-1: DIOXIN SAMPLING REGIME FOR RAW WATER



raw sample water
distilled FB water
large bottles = 4L brown glass cleaned dioxin bottles
small bottles = 1L glass chemistry bottles

Figure I-2: DIOXIN SAMPLING REGIME FOR TREATED WATER



treated sample water

distilled FB water

large bottles = 4L brown glass cleaned dioxin bottles

small bottles = 1L glass chemistry bottles

Figure I-3

MOE

DIOXIN SAMPLE DATA

Municipality________________________________ Plant______________

Date________________________________

Operator________________________________ Phone______________

Address____

Raw Water Source ____

Chemicals Used in Treatment

	Chemical	Dosage mg/L	Location
Prechlorination			
Alkalinity Adjustment			
Coagulant			
Coagulant Aid			
Post Chlorination			
Post pH Adjustment			
Taste and Odour Control			
Other			

Schematic of Plant

Retention Time

$$R.T. = \frac{\text{Volume of Plant } (m^3)}{\text{Flow } (m^3/\text{min.})} = \_\_\_\_\_\_\_\_ = \_\_\_\_\_\_\_\_ \text{minutes}$$

-Return field sheets to the laboratory with samples

Figure I-4

Turbidity for previous two retention times (plant data)

	Average	High	Low
Raw	________	________	________
Treated	________	________	________

Bottle Data - Lot numbers

A-Raw	B-Raw	AB-FB	Distilled Water AB-FB	C-Treated	D-Treated	CD-FB	Distilled Water CD-FB
1.____	1.____	1.____	1.____	1.____	1.____	1.____	1.____
2.____	2.____	2.____	2.____	2.____	2.____	2.____	2.____
3.____	3.____	3.____	3.____	3.____	3.____	3.____	3.____
			4.____				4.____

Sample Times

	t = 1	t = 2	t = 3	t = 4
Raw Sample				
Time	____	____	____	____
Turbidity	____	____	____	____
Treated Sample				
Time	____	____	____	____
Turbidity	____	____	____	____

Sampled by____

Address____

Phone____

Notes:____

____

____

* ideal
  - sample point without treatment for raw
  - sample point after complete treatment for treated
  - organically inert pumping and delivery system - no plastics except teflon
  - clean area, adequate clearance, constant flow
  - if not ideal outline in notes

APPENDIX II

ANALYTICAL METHODS

2.1 Laboratory Modification

The analysis of hazardous substances such as PCDD/PCDF at the part per quadrillion level requires very stringent quality assurance and quality control steps. In order to ensure no external contamination from laboratory procedures, a separate isolated clean lab was provided. No other types of samples were processed in this laboratory.

A mobile laboratory equipped with the usual laboratory services was put under a positive pressure system with an air lock entrance to minimize contamination from external dust. Frequent lab cleaning and wipe tests of all bench surfaces were carried out to ensure a clean environment was being maintained.

2.2 Glassware Preparation and Proving

1. Sample Collection Glassware

All water samples were collected in previously unused, cleaned amber 4 litre glass bottles equipped with teflon-lined screw caps. Each bottle was rinsed once with 100-200 mls of pentane. To check for contaminants, pentane extracts from 18-bottle lots were combined and evaporated (by roto-evaporation and under nitrogen) to 60 uL. The concentrated extract was analysed by electron capture capillary gas chromatograph (GC) for any interfering peaks in the PCDD/PCDF elution range. If any interfering peaks were present, the bottles were recleaned and the extract reanalysed until no signal was observed. All bottles were marked with a lot number corresponding to the Electron Capture Detector (ECD/GC) scan number.

2. Distilled/Deionized Water

Twelve litres of distilled deionized water (4 x 4 litre bottles) were taken to each sampling location and utilized as field blanks. Distilled water was processed in 36 bottle lots. Bottles #12, #24, and #36 in each lot were removed combined and processed as a dioxin sample. If no PCDD/PCDF interferences could be detected by gas chromatography/mass spectrometry (GC-MS) at a detection limit of 10 ppq, the distilled/deionized water was considered free of interferences. Each bottle was numbered with a lot number which referred to the GC/MS analysis.

3. Analytical Glassware

All analytical glassware dedicated to this water program was individually washed with soap and consecutively rinsed with large quantities of water, acetone, methanol, hexane and methylene chloride. It was stored by covering with pre-washed Aluminum foil.

Prior to analysis, each set of glassware was rinsed with a 100 ml aliquot of methylene chloride. The methylene chloride was concentrated under nitrogen in a Pierce reacti-vial to 10 ul. These 10 ul extracts were analysed chromatographically by ECD. If no interfering peaks in the PCDD/PCDF elution range would be detected, the glassware set was considered clean.

2.3 Extraction and Clean-up

An isotopically labeled PCDD was added to all samples upon receipt in the lab. Monitoring the recovery of this compound throughout the analysis provided an indication of the efficiency of the methodology for any native PCDD/PCDF in the sample.

For this program all samples, including field blanks, were spiked with ^{13}C-2,3,7,8-TCDD in the original sampling containers before extraction. A total of 275 picograms (28 ppq) were added to each sample by spiking all three 4-litre containers of a sample with 25 microlitres each of a standard solution containing 3.67 pg/uL ^{13}C-2,3,7,8-TCDD in acetonitrile. This spiking solution was periodically prepared from a stock solution having a concentration of 100 ng/uL. After spiking, the sample in each 4-litre container was mixed by inverting the container 5 times.

Water samples were extracted by stirring 800 ml aliquots with three 100 ml volumes (distilled-in-grade) of pentane glass in volumetric flasks. Only one extraction vessel was used for each individual 12 litre sample. Sample extracts were concentrated to a few millilitres by rotary evaporation and nitrogen blow-down.

All samples were passed through a two-stage clean-up column. Chromatographic packings used in the clean-up steps included silica gel, alumina, 44% sulphuric acid/silica, 33% NaOH/silica and 10% $AgNO_3$/silica. The preparation of these packings is detailed elsewhere (5). The top chromatographic column (10 cm x 10 mm ID) was loaded sequentially as follows: a glass wool plug, 10 g of $AgNO_3$/silica, 0.5 g of silica, 1.0 g of 33% NaOH/silica, 0.5 g silica and 2.0 g of 44% H_2SO_4/silica.

√

This column was fitted onto the top of a second column (28 cm x 6 mm ID) which had been fitted with a glass wool plug and filled with basic alumina (Bio Rad) to a height of 21 cm. The sample extract was applied to the top of the column using a disposable pipette. The sample container was rinsed with 2 x 1 ml of pentane and the solvent was transferred on to the column.

A reservoir was fitted into the top of the column and the sample was eluted with 100 ml of pentane. The top column was then removed and the reservoir was fitted on to the top of the alumina column. The alumina column is eluted sequentially with 10 ml pentane, 40 ml of 10% carbon tetrachloride/pentane and 30 ml methylene chloride. The methylene chloride fraction was reduced in volume under nitrogen to dryness, and made up to 10 ul using iso-octane.

A procedure blank was included in the analysis of each location. This was done by passing solvent only (no water sample) through all steps of the analytical procedure. This blank would provide an indication of any contamination introduced from the solvent, column packings, evaporation or any other parts of the procedure.

2.4 Instrumental Analysis

(a) Low Resolution Mass Spectrometry

All sample extracts were analysed using capillary gas chromatography/low resolution mass spectrometry. Identification was through monitoring multiple ions for each homolog group of PCDD/PCDF. These ions are listed in Table II - 1 with other GC/MS parameters.

√

The detection limits for PCDD/PCDF homologs using the GC/MS procedure are listed in Table II - 1.

For identification of PCDD/PCDF in samples, the following criteria were employed:

1. Correct retention time region for each homolog group based on PCDD/PCDF standard containing representatives of each homolog group.

2. Correspondence of peaks for 2 or 3 characteristic ions monitored for each homolog group.

3. Correct chlorine isotope ratios to within ± 15% of theoretically correct ratios for each homolog group.

4. Response of each ion had to be at least 3 times greater than instrumental background noise.

5. All peaks passing criteria 1-4 were confirmed by high resolution gas chromatography, high resolution mass spectrometry (12,000 resolution).

All quantification of positive samples was performed using low resolution mass spectrometry. Detection limits are noted in Table II - 2. All quantification was performed by adjusting for percent recovery of C^{13}2,3,7,8-TCDD.

2.5 Criteria for Data Acceptance

1. All peaks detected during an analysis had to satisfy the usual criteria for PCDD/PCDF identification. This included specific clean-up procedures, detection in the correct retention time window, correspondence of 2 or 3 ions having relative abundances within ± 15% of the theoretical values, and peak height 3 x average background noise. All peaks passing these criteria were further confirmed by high resolution mass spectrometry.

2. All M.O.E. raw and treated waters were sampled in duplicate. Validation of all PCDD/PCDF peaks which passed the criteria in #1 above included detection in both duplicate samples.

3. Duplicate samples from selected sites were analyzed by Health and Welfare, Canada. These included raw and treated waters for Easterly and RC Harris WTP, Toronto, and treated water from Oakville and Lakeview WTP. These samples were analyzed for total TCDD, total TCDF and total P_5CDD. Data was considered valid if similar results were obtained in both duplicate M.O.E. samples or duplicate H & W samples.

4. In samples where an obvious case of contamination has occurred for any of the homologue series, the entire sample was discarded. Obvious contamination was defined as high levels of GC/MS interferences in the mass range of the PCDD/PCDF homolog monitored.

TABLE II - 1

LOW RESOLUTION GC/MS OPERATING PARAMETERS

(i) Ions Monitored

Homolog group	m/z
T_4CDD	320,322
T_4CDF	304,306
P_5CDD	354, 356, 358
P_5CDF	338, 340, 342
H_6CDD	388, 390, 392
H_6CDF	372, 374, 376
H_7CDD	422, 424, 426
H_7CDF	406, 408, 410
OCDD	458, 460
OCDF	442, 444
C^{13}2, 3, 7, 8-TCDD	332, 334
C^{13} OCDD	470, 472

(ii) GC/MS Conditions

0.22 mm x 30 m HP Ultrabond DB1 programmed from 80^{o} - 235^{o}

15^{o} min., 235 - 280^{o} @ 5^{o}/min.

Electron multiplier 1200 - 1800 EV

Electron energy 35 EV

Source T^{o} $150^{o}C$

TABLE II - 2

DETECTION LIMITS FOR

PCDD/PCDF ANALYSIS OF

DRINKING WATER SUPPLIES

total tetrachlorodioxin (T_4CDD)	10 ppq
total tetrachlorofuran (T_4CDF)	10 ppq
total pentachlorodioxin (P_5CDD)	10 ppq
total pentachlorofuran (P_5CDF)	10 ppq
total hexachlorodioxin (H_6CDD)	10 ppq
total hexachlorofuran (H_6CDF)	10 ppq
total heptachlorodioxin (H_7CDD)	10 ppq
total heptachlorofuran (H_7CDF)	10 ppq
octachlorodioxin (OCDD)	10 ppq
octachlorofuran (OCDF)	10 ppq

APPENDIX III

MINISTRY OF THE ENVIRONMENT AND

HEALTH & WELFARE, CANADA DATA FOR

SURVEY OF ONTARIO DRINKING WATER SUPPLIES FOR PCDD/PCDF

DATA SUMMARY:

SURVEY OF CHLORINATED DIBENZODIOXINS

AND CHLORINATED DIBENZOFURANS IN SELECTED

TREATED DRINKING WATER SUPPLIES IN ONTARIO

Location	Sampling Date	Total Dioxins(ppq) # Chlorines					Total Furans(ppq) # Chlorines				
		4	5	6	7	8	4	5	6	7	8
RC Harris	83/6/6	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
Easterly	83/6/9	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
St. Catharines	83/6/22	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
Welland	83/6/23	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
Niagara Falls	83/7/12	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
Fort Erie	83/7/12	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
Lakeview	83/7/25	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
Oakville	83/7/27	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
Burlington	83/7/27	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
Lorne Park	83/8/11	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
Oshawa	83/8/23	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
Hamilton	83/8/23	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
Lakeview	83/9/7	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
RL Clark	83/9/8	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
Port Colborne	83/9/26	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd

DATA SUMMARY:

SURVEY OF CHLORINATED DIBENZODIOXINS

AND CHLORINATED DIBENZOFURANS IN SELECTED

RAW DRINKING WATER SUPPLIES IN ONTARIO

Location	Sampling Date	Total Dioxins(ppq) # Chlorines 4 5 6 7 8	Total Furans(ppq) # Chlorines 4 5 6 7 8
RC Harris	83/6/6	nd nd nd nd nd	nd nd nd nd nd
Easterly	83/6/9	nd nd nd nd nd	nd nd nd nd nd
St. Catharines	83/6/22	nd nd nd nd 46/33	nd nd nd nd nd
Welland	83/6/23	nd nd nd nd nd	nd nd nd nd nd
Niagara Falls	83/7/12	nd nd nd nd nd	nd nd nd nd nd
Fort Erie	83/7/12	nd nd nd nd nd	nd nd nd nd nd
Lakeview	83/7/25	nd nd nd nd 29/31	nd nd nd nd nd
Oakville	83/7/27	nd nd nd nd nd	nd nd nd nd nd
Burlington	83/7/27	nd nd nd nd nd	nd nd nd nd nd
Lorne Park	83/8/11	nd nd nd nd nd	nd nd nd nd nd
Oshawa	83/8/23	nd nd nd nd nd	nd nd nd nd nd
Hamilton	83/8/23	nd nd nd nd nd	nd nd nd nd nd
Lakeview	83/9/7	nd nd nd nd nd	nd nd nd nd nd
RL Clark	83/9/8	nd nd nd nd nd	nd nd nd nd nd
Port Colborne	83/9/26	nd nd nd nd nd	nd nd nd nd nd

Location	Sample Type	Date Collected	Analysed by	Recovery of Spike(%)+	Dioxins (ppq) Measured # of Chlorines 4 5 6 7 8	Furans Measured # of Chlorines 4 5 6 7 8
RC Harris (i)	raw (A)	June 6/83	M.O.E.	4	nd nd nd nd nd	nd nd nd nd nd
	raw (B)	June 6/83	M.O.E.	94	nd nd nd nd nd	nd nd nd nd nd
	raw (C)	June 6/83	H & W	9	nd nd * * *	nd * * * *
	raw field blk.	June 6/83	M.O.E.	80	nd nd nd nd nd	nd nd nd nd nd
	raw field blk.	June 6/83	H & W	5	nd nd * * *	nd * * * *
(ii)	treated(C)	June 6/83	M.O.E.	100	nd nd nd nd nd	nd nd nd nd nd
	treated(D)	June 6/83	M.O.E.	82	nd nd nd nd nd	nd nd nd nd nd
	treated(E)	June 6/83	H & W	31	nd nd * * *	nd * * * *
	treated field blk.	June 6/83	M.O.E.	55	nd nd nd nd nd	nd nd nd nd nd
	treated field blk.	June 6/83	H & W	9	nd nd * * *	nd * * * *

+ All samples spikes with ^{13}C-2,3,7,8-TCDD before extraction

nd = not detected at detection limit of 10 ppq per isomer (parts-per-quadrillion)

Samples A, B = duplicate raw water samples

Samples C, D = duplicate treated water samples

* not analysed by H & W

Location	Sample Type	Date Collected	Analysed by	Recovery of Spike(%)+	Dioxins (ppq) Measured: # of Chlorines 4	5	6	7	8	Furans Measured: # of Chlorines 4	5	6	7	8
Easterly (i)	raw (A)	June 9/83	M.O.E.	31	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
	raw (B)	June 9/83	M.O.E.	13	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
	raw (C)	June 9/83	H & W	30	nd	nd	*	*	*	nd	*	*	*	*
	raw field blk.	June 9/83	M.O.E.	51	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
	raw field blk.	June 9/83	H & W	5	nd	nd	*	*	*	nd	*	*	*	*
(ii)	treated(D)	June 9/83	M.O.E.	40	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
	treated(E)	June 9/83	M.O.E.	29	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
	treated(F)	June 9/83	H & W	9	nd	nd	*	*	*	nd	*	*	*	*
	treated field blk.	June 9/83	M.O.E.	54	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
	treated field blk.	June 9/83	H & W	8	nd	nd	*	*	*	nd	*	*	*	*

+ All Samples spiked with ^{13}C-2,3,7,8-TCDD before extraction

nd = not detected at detection limit of 10 ppq per isomer (parts-per-quadrillion)

Samples A, B, C = duplicate raw water samples

Samples D, E, F = duplicate treated water samples

* not analysed by H & W

Location		Sample Type	Date Collected	Analysed by	Recovery of Spike(%)+ (TCDD)	Dioxins (ppq) Measured # of Chlorines 4 5 6 7 8	Furans (ppq) Measured # of Chlorines 4 5 6 7 8
St.Catharines	(i)	raw (A)	June 22/83	M.O.E.	84	nd nd nd nd 46	nd nd nd nd nd
		raw (B)	June 22/83	M.O.E.	71	nd nd nd nd 33	nd nd nd nd nd
		raw field blk.	June 22/83	M.O.E.	115	nd nd nd nd nd	nd nd nd nd nd
	(ii)	treated(C)	June 22/83	M.O.E.	114	nd nd nd nd nd	nd nd nd nd nd
		treated(D)	June 22/83	M.O.E.	94	nd nd nd nd nd	nd nd nd nd nd
		treated field blk.	June 22/83	M.O.E.	106	nd nd nd nd nd	nd nd nd nd nd

+ All samples spiked with ^{13}C-2,3,7,8-TCDD before extraction

nd = not detected at detection limit of 10 ppq per isomer (parts-per-quadrillion)

Samples A, B = duplicate raw water samples

Samples C, D = duplicate treated water samples

Location	Sample Type	Date Collected	Analysed by	Recovery of Spike(%)+	Dioxins (ppq) Measured	Furans(ppq) Measured
					# of Chlorines 4 5 6 7 8	# of Chlorines 4 5 6 7 8
Welland	raw (A)	June 23/83	M.O.E.	94	nd nd nd nd nd	nd nd nd nd nd
	raw (B)	June 23/83	M.O.E.	88	nd nd nd nd nd	nd nd nd nd nd
	treated(C)	June 23/83	M.O.E.	76	nd nd nd nd nd	nd nd nd nd nd
	treated(D)	June 23/83	M.O.E.	86	nd nd nd nd nd	nd nd nd nd nd
	treated field blk.	June 23/83	M.O.E.	59	nd nd nd nd nd	nd nd nd nd nd

+ All samples spiked with ^{13}C-2,3,7,8-TCDD before extraction

nd = not detected at detection limit of 10 ppq per isomer (parts-per-quadrillion)

Samples A, B = duplicate raw water samples

Samples C, D = duplicate treated water samples

Location	Sample Type	Date Collected	Analysed by	Recovery of Spike(%)+	Dioxin (ppq) Measured # of Chlorines 4 5 6 7 8	Furans Measured # of Chlorines 4 5 6 7 8
Niagara Falls	raw (A)	July 12/83	M.O.E.	16	nd nd nd nd nd	nd nd nd nd nd
	raw (B)	July 12/83	M.O.E.	25	nd nd nd nd nd	nd nd nd nd nd
	raw field blk.	July 12/83	M.O.E.	125	nd nd nd nd nd	nd nd nd nd nd
	treated(C)	July 12/83	M.O.E.	13	nd nd nd nd nd	nd nd nd nd nd
	treated(D)	July 12/83	M.O.E.	48	nd nd nd nd nd	nd nd nd nd nd
	treated field blk.	July 12/83	M.O.E.	44	nd nd nd nd nd	nd nd nd nd nd

+All samples spiked with C^{13}2,3,7,8-TCDD before extraction

nd = not detected at detection limit of 10 ppq per isomer (parts-per-quadrillion)

Samples A, B = duplicate raw water

Samples C, D = duplicate treated water

Location	Sample Type	Date Collected	Analysed by	Recovery of Spike(%)+	Dioxin (ppq) Measured	Furans Measured
					# of Chlorines 4 5 6 7 8	# of Chlorines 4 5 6 7 8
Fort Erie	raw (A)	July 12/83	M.O.E.	76	nd nd nd nd nd	nd nd nd nd nd
	raw (B)	July 12/83	M.O.E.	58	nd nd nd nd nd	nd nd nd nd nd
	raw field blk.	July 12/83	M.O.E.	116	nd nd nd nd nd	nd nd nd nd nd
	treated(C)	July 12/83	M.O.E.	81	nd nd nd nd nd	nd nd nd nd nd
	treated(D)	July 12/83	M.O.E.	41	nd nd nd nd nd	nd nd nd nd nd
	treated field blk.	July 12/83	M.O.E.	108	nd nd nd nd nd	nd nd nd nd nd

+All samples spiked with C^{13}2,3,7,8-TCDD before extraction

nd = not detected at detection limit of 10 ppq per isomer (parts-per-quadrillion)

Samples A, B = duplicate raw water

Samples C, D = duplicate treated water

Location	Sample Type	Date Collected	Analysed by	Recovery of Spike(%)+	Dioxin (ppq) Measured # of Chlorines 4 5 6 7 8	Furans Measured # of Chlorines 4 5 6 7 8
Lakeview	raw (A)	July 25/83	M.O.E.	34	nd nd nd nd 29	nd nd nd nd nd
	raw (B)	July 25/83	M.O.E.	16	nd nd nd nd 31	nd nd nd nd nd
	raw field blk.	July 25/83	M.O.E.	52	nd nd nd nd nd	nd nd nd nd nd
	treated(C)	July 25/83	M.O.E.	75	nd nd nd nd nd	nd nd nd nd nd
	treated(D)	July 25/83	M.O.E.	29	nd nd nd nd nd	nd nd nd nd nd
	treated field blk.	July 25/83	M.O.E.	32	nd nd nd nd nd	nd nd nd nd nd

+All samples spiked with C^{13}2,3,7,8-TCDD before extraction

nd = not detected at detection limit of 10 ppq per iosomer (parts-per-quadrillion)

Samples A, B = duplicate raw water

Samples C, D = duplicate treated water

Location	Sample Type	Date Collected	Analysed by	Recovery of Spike(%)+	Dioxin (ppq) Measured # of Chlorines 4 5 6 7 8	Furans Measured # of Chlorines 4 5 6 7 8
Oakville	raw (A)	July 27/83	M.O.E.		nd nd nd nd nd	nd nd nd nd nd
	raw (B)	July 27/83	M.O.E.	180	nd nd nd nd nd	nd nd nd nd nd
	raw field blk.	July 27/83	M.O.E.	81	nd nd nd nd nd	nd nd nd nd nd
	treated(C)	July 27/83	M.O.E.		------------	------------
	treated(D)	July 27/83	M.O.E.	72	nd nd nd nd nd	nd nd nd nd nd
	treated(E)	July 27/83	H & W	34	nd * * * *	* * * * *
	treated(F)	July 27/83	H & W	108	nd * * * *	* * * * *
	treated field blk.	July 27/83	M.O.E.	62	nd nd nd nd nd	nd nd nd nd nd
	treated field blk.	July 27/83	H & W	49	nd * * * *	* * * * *

+All samples spiked with C^{13}2,3,7,8-TCDD before extraction

nd = not detected at detection limit of 10 ppq per isomer (parts-per-quadrillion)

Samples A, B = duplicate raw water samples

Samples C, D, E, F = duplicate treated water samples

*not analysed by H & W

------------ spoilt sample

Location		Sample Type	Date Collected	Analysed by	Recovery of Spike(%)+	Dioxins (ppq) Measured # of Chlorines 4 5 6 7 8	Furans Measured # of Chlorines 4 5 6 7 8
Burlington	(i)	raw (A)	Aug. 9/83	M.O.E.	89	nd nd nd nd nd	nd nd nd nd nd
		raw (B)	Aug. 9/83	M.O.E.	53	nd nd nd nd nd	nd nd nd nd nd
		raw field blk.	Aug. 9/83	M.O.E.	33	nd nd nd nd nd	nd nd nd nd nd
	(ii)	treated(C)	Aug. 9/83	M.O.E.	98	nd nd nd nd nd	nd nd nd nd nd
		treated(D)	Aug. 9/83	M.O.E.	62	nd nd nd nd nd	nd nd nd nd nd
		treated field blk.	Aug. 9/83	M.O.E.	15	nd nd nd nd nd	nd nd nd nd nd

+All samples spiked with C^{13} 2,3,7,8-TCDD before extraction

nd = not detected at detection limit of 10 ppq per isomer (parts-per-quadrillion)

Samples A, B = duplicate raw water samples

Samples C, D = duplicate treated water samples

Location	Sample Type	Date Collected	Analysed by	Recovery of Spike(%)+	Dioxin (ppq) Measured					Furans Measured				
					# of Chlorines					# of Chlorines				
					4	5	6	7	8	4	5	6	7	8
Lorne Park	raw (A)	Aug. 11/83	M.O.E.	100	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
	raw (B)	Aug. 11/83	M.O.E.	107	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
	raw field blk.	Aug. 11/83	M.O.E.	135	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
	treated(C)	Aug. 11/83	M.O.E.	86	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
	treated(D)	Aug. 11/83	M.O.E.	96	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
	treated field blk.	Aug. 11/83	M.O.E.	75	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd

+All samples spiked with C^{13}2,3,7,8-TCDD before extraction

nd = not detected at detection limit of 10 ppq per isomer (parts-per-quadrillion)

Samples A, B = duplicate raw water

Samples C, D = duplicate treated water

Location	Sample Type	Date Collected	Analysed by	Recovery of Spike(%)+	Dioxin (ppq) Measured					Furans Measured				
					# of Chlorines					# of Chlorines				
					4	5	6	7	8	4	5	6	7	8
Oshawa	raw (A)	Aug. 22/83	M.O.E.	54	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
	raw (B)	Aug. 22/83	M.O.E.	11	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
	raw field blk.	Aug. 22/83	M.O.E.	20	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
	treated(C)	Aug. 22/83	M.O.E.	27	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
	treated(D)	Aug. 22/83	M.O.E.	28	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
	treated field blk.	Aug. 22/83	M.O.E.	22	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd

+All samples spiked with C^{13}2,3,7,8-TCDD before extraction

nd = not detected at detection limit of 10 ppq per isomer (parts-per-quadrillion)

Samples A, B = duplicate raw water

Samples C, D = duplicate treated water

Location	Sample Type	Date Collected	Analysed by	Recovery of Spike(%)+	Dioxin (ppq) Measured					Furans Measured				
					# of Chlorines					# of Chlorines				
					4	5	6	7	8	4	5	6	7	8
Hamilton	raw (A)	Aug. 23/83	M.O.E.	9	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
	raw (B)	Aug. 23/83	M.O.E.	26	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
	raw field blk.	Aug. 23/83	M.O.E.	33	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
	treated(C)	Aug. 23/83	M.O.E.	23	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
	treated(D)	Aug. 23/83	M.O.E.	30	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
	treated field blk.	Aug. 23/83	M.O.E.	22	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd

+All samples spiked with C^{13}2,3,7,8-TCDD before extraction

nd = not detected at detection limit of 10 ppq per isomer (parts-per-quadrillion)

Samples A, B = duplicate raw water

Samples C, D = duplicate treated water

Location	Sample Type	Date Collected	Analysed by	Recovery of Spike(%)+	Dioxin (ppq) Measured # of Chlorines					Furans Measured # of Chlorines				
					4	5	6	7	8	4	5	6	7	8
Lakeview	raw (A)	Sept. 7/83	M.O.E.	0	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
	raw (B)	Sept. 7/83	M.O.E.	28	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
	raw field blk.	Sept. 7/83	M.O.E.	15	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
	treated(C)	Sept. 7/83	M.O.E.	240	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
	treated(D)	Sept. 7/83	M.O.E.	57	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
	treated field blk.	Sept. 7/83	M.O.E.	190	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd

+All samples spiked with C^{13}2,3,7,8-TCDD before extraction

nd = not detected at detection limit of 10 ppq per isomer (parts-per-quadrillion)

Samples A, B = duplicate raw water

Samples C, D = duplicate treated water

Location	Sample Type	Date Collected	Analysed by	Recovery of Spike(%)+	Dioxin (ppq) Measured	Furans Measured
					# of Chlorines 4 5 6 7 8	# of Chlorines 4 5 6 7 8
Clark	raw (A)	Sept. 8/83	M.O.E.	83	nd nd nd nd -	nd nd nd nd -
	raw (B)	Sept. 8/83	M.O.E.	120	nd nd nd nd -	nd nd nd nd -
	raw field blk.	Sept. 8/83	M.O.E.	86	nd nd nd nd -	nd nd nd nd -
	treated(C)	Sept. 8/83	M.O.E.	190	nd nd nd nd -	nd nd nd nd -
	treated(D)	Sept. 8/83	M.O.E.	300	nd nd nd nd -	nd nd nd nd -
	treated field blk.	Sept. 8/83	M.O.E.	89	nd nd nd nd -	nd nd nd nd -

+All samples spiked with C^{13}2,3,7,8-TCDD before extraction

nd = not detected at detection limit of 10 ppq per isomer (parts-per-quadrillion)

Samples A, B = duplicate raw water

Samples C, D = duplicate treated water

- OCDD - not determined due to interference

- OCDF - not determined due to interference

Location	Sample Type	Date Collected	Analysed by	Recovery of Spike(%)+	Dioxin (ppq) Measured	Furans Measured
					# of Chlorines 4 5 6 7 8	# of Chlorines 4 5 6 7 8
Port Colborne	raw (A)	Sept. 26/83	M.O.E.	5	nd nd nd nd nd	nd nd nd nd nd
	raw (B)	Sept. 26/83	M.O.E.	27	nd nd nd nd nd	nd nd nd nd nd
	raw field blk.	Sept. 26/83	M.O.E.	36	nd nd nd nd nd	nd nd nd nd nd
	treated(C)	Sept. 26/83	M.O.E.	15	nd nd nd nd nd	nd nd nd nd nd
	treated(D)	Sept. 26/83	M.O.E.	22	nd nd nd nd nd	nd nd nd nd nd
	treated field blk.	Sept. 26/83	M.O.E.	38	nd nd nd nd nd	nd nd nd nd nd

+All samples spiked with C^{13}2,3,7,8-TCDD before extraction

nd = not detected at detection limit of 10 ppq per isomer (parts-per-quadrillion)

Samples A, B = duplicate raw water

Samples C, D = duplicate treated water

APPENDIX IV

SUPPORT CHEMISTRY FOR SURVEY OF ONTARIO DRINKING WATER SUPPLIES FOR PCDD/PCDF

SUPPORT CHEMISTRY FOR DIOXIN SAMPLING

Location: R.C. Harris

Date: June 6, 1983

Parameter/ Concentration	Sample Description Raw AB-1	Raw AB-2	Raw AB-3	Raw AB-4	Raw AB-FB	Treated CD-1	Treated CD-2	Treated CD-3	Treated CD-4	Treated CD-FB
Conductivity 25C	332	332	332	333	2.9	333	334	333	334	2.4
Hardness, Total (mg/L as $CaCO_3$)	129	132	135	134	1.7	129	133	131	133	1.7
Calcium, UNF Reactive (mg/L as C)	38	39	41	40	0	38	40	39	39	0.5
Magnesium UNF Reactive (mg/L as Mg)	8.0	8.0	8.0	8.0	0.10	8.0	8.2	8.1	8.2	0.10
Alkalinity Total (mg/L as $CaCO_3$)	95	96	96	98	4.4	89	90	90	90.	3.8
pH	8.2	8.2	8.2	8.2	6.2	7.5	7.6	7.5	7.5	6.1
Residue Total (mg/L)	216	217	216	216	2.0	216	217	216	217	2.0
Turbidity (FTU)	0.7	0.7	0.7	0.8	0.2	0.2	0.2	0.2	0.3	0.2
Colour Apparent (HZU)	4.5	4.5	4.5	4.5	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1

SUPPORT CHEMISTRY FOR DIOXIN SAMPLING

Location: St. Catharines (DeCaw)

Date: June 22, 1983

Parameter/ Concentration	Sample Description									
	Raw AB-1	Raw AB-2	Raw AB-3	Raw AB-4	Raw AB-FB	Treated CD-1	Treated CD-2	Treated CD-3	Treated CD-4	Treated CD-FB
Conductivity 25C	316	316	316	316	3.1	319	320	320	320	3.3
Hardness, Total (mg/L as $CaCO_3$)	137	137	135	135	<0.5	132	125	126	127	<0.5
Calcium, UNF Reactive (mg/L as C)	37	38	38	38	<0.1	35	35	35	36	<0.1
Magnesium UNF Reactive (mg/L as Mg)	9.6	9.6	9.6	9.6	<0.05	8.9	8.9	9.0	9.1	<0.05
Alkalinity Total (mg/L as $CaCO_3$)	105	105	104	105	3.2	98	100	102	99	4.2
pH	8.2	8.3	8.3	8.3	7.1	8.0	8.0	7.9	7.9	6.7
Residue Total (mg/L)	192	196	198	201	3.6	205	191	205	205	3.8
Turbidity (FTU)	7.2	7.0	6.9	7.0	0.1	0.2	0.2	0.2	0.2	0.1
Colour Apparent (HZU)	10	10	10	11	<0.1	1.5	1.5	1.5	1.5	<0.1

SUPPORT CHEMISTRY FOR DIOXIN SAMPLING

Location: Easterly Water Treatment Plant

Date: June 9, 1983

Parameter/ Concentration	Sample Description Raw AB-1	Raw AB-2	Raw AB-3	Raw AB-4	Raw AB-FB	Treated CD-1	Treated CD-2	Treated CD-3	Treated CD-4	Treated CD-FB
Conductivity 25C	330	330	331	331	2.8	336	335	336	337	2.9
Hardness, Total (mg/L as $CaCO_3$)	126	129	132	132	1.7	132	134	136	134	1.7
Calcium, UNF Reactive (mg/L as C)	37	38	39	39	0.5	39	40	41	40	0.5
Magnesium UNF Reactive (mg/L as Mg)	8.3	8.4	8.3	8.3	0.1	8.0	8.1	8.1	8.1	0.1
Alkalinity Total (mg/L as $CaCO_3$)	97	90	98	97	3.2	88	88	88	89	4.0
pH	8.2	8.26	8.26	8.28	6.40	7.55	7.55	7.56	7.54	6.40
Residue Total (mg/L)	214	214	215	215	2.0	218	218	218	219	2.0
Turbidity (FTU)	0.7	0.7	0.8	0.9	0.2	0.4	0.4	0.4	0.4	0.2
Colour Apparent (HZU)	4.5	4.5	4.5	4.5	<0.02	0.7	0.7	<0.1	<0.1	<0.1

SUPPORT CHEMISTRY FOR DIOXIN SAMPLING

Location: Lakeview WTP

Date: July 25, 1983

Parameter/ Concentration	Sample Description									
	Raw AB-1	Raw AB-2	Raw AB-3	Raw AB-4	Raw AB-FB	Treated CD-1	Treated CD-2	Treated CD-3	Treated CD-4	Treated CD-FB
Conductivity 25C	335	336	336	336	2.5	341	342	341	342	2.2
Hardness, Total (mg/L as $CaCO_3$)	129	129	132	128	0.5<W	124	124	129	131	0.5<W
Calcium, UNF Reactive (mg/L as C)	38	38	39	38	0.1<W	36	37	38	39	0.1<W
Magnesium UNF Reactive (mg/L as Mg)	8.1	8.2	8.3	8.2	0.05<W	8.3	8.4	8.20	8.30	0.05<W
Alkalinity Total (mg/L as $CaCO_3$)	95	95	94	94	6.2	87	87	87	88	2.8
pH	8.1	8.1	8.1	8.1	6.2	7.5	7.5	7.5	7.5	6.1
Residue Total (mg/L)	218(CRO)	218(CRO)	218(CRO)	218(CRO)	2.0(CRO)	221(CRO)	222(CRO)	221(CRO)	222(CRO)	1.4 (CRO)
Turbidity (FTU)	1.5	1.6	1.5	1.4	0.4	0.5	0.5	0.5	0.5	0.4
Colour Apparent (HZU)	8.2	7.5	8.2	8.2	0.1<W	1.5	1.5	3.0	1.5	0.1<W

<W - less than detection limit

CRO - calculated result only

SUPPORT CHEMISTRY FOR DIOXIN SAMPLING

Location: Hamilton

Date: August 23, 1983

Parameter/ Concentration	Sample Description Raw AB-1	Raw AB-2	Raw AB-3	Raw AB-4	Raw AB-FB	Treated CD-1	Treated CD-2	Treated CD-3	Treated CD-4	Treated CD-FB
Conductivity 25C	313	313	313	314	2.20	325	327	326	327	2.3
Hardness, Total (mg/L as $CaCO_3$)	130	130	129	132	0.5<W	128	129	130	126	0.5<W
Calcium, UNF Reactive (mg/L as C)	38	38	37	38	0.1<W	37	37	38	36	0.1<W
Magnesium UNF Reactive (mg/L as Mg)	8.7	8.6	8.7	8.8	0.05<W	8.6	8.6	8.6	8.5	0.05<W
Alkalinity Total (mg/L as $CaCO_3$)	89	89	89	89	3.4<W	83	84	84	84	4.0<W
pH	8.3	8.3	8.3	8.2	6.3	8.3	8.2	8.0	8.2	6.5
Residue Total (mg/L)	205(CRO)	207(CRO)	208(CRO)	208(CRO)	1.6(CRO)	216(CRO)	216(CRO)	216(CRO)	216(CRO)	2.0 (CRO)
Turbidity (FTU)	2.2	2.1	2.2	2.2	0.1	0.5	0.5	0.5	0.5	0.2
Colour Apparent (HZU)	5.2	5.2	4.5	5.2	0.1<W	3.0	3.0	3.0	3.0	0.1<W

<W - below detection limit

CRO - calculated result only

SUPPORT CHEMISTRY FOR DIOXIN SAMPLING

Location: Toronto Island

Date: September 15, 1983

Parameter/ Concentration	Sample Description Raw AB-1	Raw AB-2	Raw AB-3	Raw AB-4	Raw AB-FB	Treated CD-1	Treated CD-2	Treated CD-3	Treated CD-4	Treated CD-FB
Conductivity 25C	333	333	333	333	2.5	338	338	337	338	2.3
Hardness, Total (mg/L as $CaCO_3$)	135	135	136	137	0.5<W	133	130	131	138	0.5<W
Calcium, UNF Reactive (mg/L as C)	40	40	40	41	0.1<W	39	38	39	41	0.1<W
Magnesium UNF Reactive (mg/L as Mg)	8.6	8.6	8.7	8.6	0.05<W	8.6	8.4	8.3	8.7	0.05<W
Alkalinity Total (mg/L as $CaCO_3$)	94	95	94	95	4.4	86	87	87	87	4.8
pH	8.1	8.1	8.1	8.1	6.6	7.7	7.7	7.9	7.6	6.6
Residue Total (mg/L)	216 (CRO)	216 (CRO)	216 (CRO)	216 (CRO)	1.6 (CRO)	219 (CRO)	219 (CRO)	219 (CRO)	220 (CRO)	1.6 (CRO)
Turbidity (FTU)	1.8	2.0	2.0	1.7	0.2	0.3	0.3	0.3	0.3	0.2
Colour Apparent (HZU)	5.2	6.7	6.7	6.7	0.1<W	1.5	1.5	1.5	0.5	0.1<W

<W - below detection limit

CRO - calculated result only

SUPPORT CHEMISTRY FOR DIOXIN SAMPLING

Location: R.L. Clark

Date: Sept. 8, 1983

Parameter/ Concentration	Sample Description									
	Raw AB-1	Raw AB-2	Raw AB-3	Raw AB-4	Raw AB-FB	Treated CD-1	Treated CD-2	Treated CD-3	Treated CD-4	Treated CD-FB
Conductivity 25C	337	338	337	377	2.6	342	341	341	342	2.3
Hardness, Total (mg/L as $CaCO_3$)	132	129	132	131	0.5<W	131	131	132	131	0.5<W
Calcium, UNF Reactive (mg/L as C)	39	38	39	38	0.1<W	38	38	39	38	0.1<W
Magnesium UNF Reactive (mg/L as Mg)	8.5	8.5	8.6	8.6	0.05<W	8.6	8.5	8.6	8.4	0.05<W
Alkalinity Total (mg/L as $CaCO_3$)	95	95	96	96	4.4	89	88	89	88	4.6
pH	7.9	7.9	7.9	7.8	6.5	7.6	7.8	7.5	7.6	6.35
Residue Total (mg/L)	219(CRO)	219(CRO)	218(CRO)	219(CRO)	1.6(CRO)	222(CRO)	221(CRO)	221(CRO)	222(CRO)	1.6 (CRO)
Turbidity (FTU)	1.0	1.0	1.0	1.0	0.1	0.3	0.3	0.3	0.3	0.1
Colour Apparent (HZU)	3.7	3.7	3.7	3.7	0.1<W	0.7<T	0.7<T	0.7<T	0.7<T	0.1<W

<T - tentative number, for information only

<W - below detection limit

CRO - calculated result only

SUPPORT CHEMISTRY FOR DIOXIN SAMPLING

Location: Port Colborne

Date: Sept. 26, 1983

Parameter/ Concentration	Sample Description									
	Raw AB-1	Raw AB-2	Raw AB-3	Raw AB-4	Raw AB-FB	Treated CD-1	Treated CD-2	Treated CD-3	Treated CD-4	Treated CD-FB
Conductivity 25C	294	294	294	295	2.3	297	298	298	298	2.3
Hardness, Total (mg/L as $CaCO_3$)	137	133	131	133	0.5<W	125	126	133	132	0.5<W
Calcium, UNF Reactive (mg/L as C)	40	38	37	38	0.1<W	35	36	39	38	0.1<W
Magnesium UNF Reactive (mg/L as Mg)	9.2	9.2	9.2	9.2	0.05<W	8.9	8.9	8.9	8.9	0.05<W
Alkalinity Total (mg/L as $CaCO_3$)	93	93	93	96	3.8	90	90	91	91	3.4
pH	8.4	8.4	8.4	8.4	6.2	8.0	7.9	8.0	8.0	6.2
Residue Total (mg/L)	179	179	192	186	1.6(CRO)	193 (CRO)	193(CRO)	193(CRO)	193(CRO)	1.6 (CRO)
Turbidity (FTU)	5.5	5.0	4.8	4.6	0.4	0.4	0.4	0.4	0.4	0.4
Colour Apparent (HZU)	7.5	6.7	6.7	6.7	0.1<W	0.1<W	0.1<W	0.1<W	0.7<T	0.1<W

<T - tentative number, for information only

<W - below detection limit

CRO - calculated result only

SUPPORT CHEMISTRY FOR DIOXIN SAMPLING

Location: Lakeview WTP

Date: Sept. 7, 1983

Parameter/ Concentration	Sample Description Raw AB-1	Raw AB-2	Raw AB-3	Raw AB-4	Raw AB-FB	Treated CD-1	Treated CD-2	Treated CD-3	Treated CD-4	Treated CD-FB
Conductivity 25C	338	338	338	380	2.3	343	343	342	443	2.2
Hardness, Total (mg/L as $CaCO_3$)	137	135	134	133	0.5<W	132	133	134	134	0.5<W
Calcium, UNF Reactive (mg/L as C)	40	39	39	39	0.1<W	39	39	40	39	0.1<W
Magnesium UNF Reactive (mg/L as Mg)	8.8	8.9	8.8	8.9	0.05<W	8.5	8.6	8.5	8.9	0.05<W
Alkalinity Total (mg/L as $CaCO_3$)	96	96	95	96	5.2	89	89	89	89	3.0
pH	7.8	7.8	7.8	7.8	7.1	7.6	7.6	7.5	7.5	6.36
Residue Total (mg/L)	220 (CRO)	220 (CRO)	220 (CRO)	220 (CRO)	1.6<T	223 (CRO)	223 (CRO)	223 (CRO)	223 (CRO)	1.4<T
Turbidity (FTU)	1.7	1.7	1.6	1.6	0.1	0.2	0.2	0.2	0.2	0.2
Colour Apparent (HZU)	5.2	5.2	5.2	5.2	0.1<W	0.1<W	0.1<W	0.1<W	0.1<W	0.1<W

<T - tentative number, for information only

<W - below detection limit

CRO - calculated result only

SUPPORT CHEMISTRY FOR DIOXIN SAMPLING

Location: Oshawa WTP

Date: August 22, 1983

Parameter/ Concentration	Raw AB-1	Raw AB-2	Raw AB-3	Raw AB-4	Raw AB-FB	Treated CD-1	Treated CD-2	Treated CD-3	Treated CD-4	Treated CD-FB
	Sample Description									
Conductivity 25C	308	309	309	309	2	316	315	316	316	1.9
Hardness, Total (mg/L as $CaCO_3$)	114	115	115	114	0.5<W	117	117	116	117	0.5<W
Calcium, UNF Reactive (mg/L as C)	33	33	33	22	0.1<W	34	34	33	33	0.1<W
Magnesium UNF Reactive (mg/L as Mg)	7.9	8.0	8.0	8.0	0.05<W	8.0	8.0	8.0	8.0	0.05<W
Alkalinity Total (mg/L as $CaCO_3$)	131	121	118	89	4 6	86	86	86	86	4.2<T
pH	8.3	8.3	8.3	8.3	6.6	7.7	7.7	7.7	7.7	6.3
Residue Total (mg/L)	200(CRO)	201(CRO)	201(CRO)	201(CRO)	1.4(CRO)	205(CRO)	205(CRO)	205(CRO)	205(CRO)	1.2 (CRO)
Turbidity (FTU)	2.8	2.8	2.7	2.7	0.1	0.3	0.3	0.3	0.3	0.2
Colour Apparent (HZU)	7.5	7.1	7.5	7.5	0.1<W	0.1<W	0.1<W	0.1<W	0.1<W	0.1<W

<W - below detection limit

CRO - calculated result only

<T - calculated result only

SUPPORT CHEMISTRY FOR DIOXIN SAMPLING

Location: South Peel (Lorne Park)

Date: August 11, 1983

Parameter/ Concentration	Sample Description Raw AB-1	Raw AB-2	Raw AB-3	Raw AB-4	Raw AB-FB	Treated CD-1	Treated CD-2	Treated CD-3	Treated CD-4	Treated CD-FB
Conductivity 25C	329	328	328	328	2.5	341.0	341.00	340.00	341.00	2.70
Hardness, Total (mg/L as $CaCO_3$)	131	130	131	134	0.5<W	133	133	133	132	0.5<W
Calcium, UNF Reactive (mg/L as C)	38	38	39	40	0.1<W	39	39	39	39	0.1<W
Magnesium UNF Reactive (mg/L as Mg)	8.4	8.3	8.3	8.3	0.05<W	8.2	8.4	8.4	8.4	0.05<W
Alkalinity Total (mg/L as $CaCO_3$)	94	94	94	94	2.4	90	90	90	90	2.8
pH	8.0	8.2	8.1	8.2	6.7	7.6	7.6	7.6	7.6	6.6
Residue Total (mg/L)	214(CRO)	213(CRO)	213(CRO)	213(CRO)	1.6(CRO)	222(CRO)	222(CRO)	221(CRO)	222(CRO)	1.8 (CRO)
Turbidity (FTU)	1.0	2.2	2.5	2.7	0.3	0.3	0.3	0.3	0.3	0.3
Colour Apparent (HZU)	7.5	6.0	7.8	8.6	0.1<W	0.1<W	0.1<W	0.1<W	0.1<W	0.1<W

<W - below detection limit

CRO - calculated result only

SUPPORT CHEMISTRY FOR DIOXIN SAMPLING

Location: Burlington

Date: August 9, 1983

Parameter/ Concentration	Sample Description: Raw (A)	Raw (B)	Raw (AB-FB)	Treated (C)	Treated (D)	Treated (CD-FB)
Conductivity 25C	332	332	7.4	338	337	4.0
Hardness, Total (mg/L as $CaCO_3$)	131	133	0.5<W	134	129	0.5<W
Calcium, UNF Reactive (mg/L as C)	38	39	0.5<W	40	38	0.5<W
Magnesium UNF Reactive (mg/L as Mg)	8.5	8.6	0.05<W	8.4	8.5	0.05<W
Alkalinity Total (mg/L as $CaCO_3$)	95	96	5.0	90	90	4.0
pH	8.0	8.0	6.9	7.8	7.8	7.1
Residue Total (mg/L)	216 (CRO)	216 (CRO)	4.8 (CRO)	219 (CRO)	219 (CRO)	2.6 (CRO)
Turbidity (FTU)	0.8	0.8	0.1	0.3	0.3	0.1
Colour Apparent (HZU)	4.8	4.8	0.1<W	0.1<W	0.1<W	0.1<W

<W - below detection limit

CRO - calculated result only

SUPPORT CHEMISTRY FOR DIOXIN SAMPLING

Location: Oakville WTP

Date: July 27, 1983

Parameter/ Concentration	Sample Description Raw AB-1	Raw AB-2	Raw AB-3	Raw AB-4	Raw AB-FB	Treated CD-1	Treated CD-2	Treated CD-3	Treated CD-4	Treated CD-FB
Conductivity 25C	333	333	333	333	3.6	339	339	339	339	3.4
Hardness, Total (mg/L as $CaCO_3$)	129	128	128	128	0.5<W	130	131	130	124	0.5<W
Calcium, UNF Reactive (mg/L as C)	38	37	37	38	0.1<W	38	39	38	38	0.1<W
Magnesium UNF Reactive (mg/L as Mg)	8.4	8.45	8.4	8.4	0.05<W	8.4	8.4	8.4	8.5	0.05<W
Alkalinity Total (mg/L as $CaCO_3$)	96	96	95	95	6.5	87	87	88	87	5.6
pH	8.4	8.4	8.4	8.4	6.3	7.6	7.6	7.1	7.7	6.4
Residue Total (mg/L)	216 (CRO)	216 (CRO)	216 (CRO)	216 (CRO)	2.4 (CRO)	220 (CRO)	220 (CRO)	220 (CRO)	220 (CRO)	2.2 (CRO)
Turbidity (FTU)	0.4	0.9	0.9	0.9	0.22	0.3	0.3	1.0	0.30	0.2
Colour Apparent (HZU)	6.7	6.0	6.0	6.0	0.1<W	1.5	1.5	1.5	1.5	0.1<W

<W - below detection limit

CRO - calculated result only

<T - minimum amount tentative only

SUPPORT CHEMISTRY FOR DIOXIN SAMPLING

Location: Fort Erie (Rose Hill)

Date: July 12, 1983

Parameter / Concentration	Raw AB-1	Raw AB-2	Raw AB-3	Raw AB-4	Raw AB-FB	Treated CD-1	Treated CD-2	Treated CD-3	Treated CD-4	Treated CD-FB
Conductivity 25C	393	293	294	293	3.15	296	296	296	297	3.2
Hardness, Total (mg/L as $CaCO_3$)	121	124	126	126	0.5<W	126	127	126	128	0.5<W
Calcium, UNF Reactive (mg/L as C)	35	36	36	36	0.1<W	36	37	36	37	0.1<W
Magnesium UNF Reactive (mg/L as Mg)	8.4	8.4	8.5	8.5	0.05<W	8.6	8.6	8.7	8.5	0.05<W
Alkalinity Total (mg/L as $CaCO_3$)	97	98	97	98	3.2	94	95	94	96	3.4
pH	8.4	8.4	8.5	8.5	0.05<W	8.6	8.6	8.7	7.9	6.26
Residue Total (mg/L)	190(CRO)	190(CRO)	190(CRO)	190(CRO)	2.2<T	192(CRO)	192(CRO)	192(CRO)	193(CRO)	2.2<T
Turbidity (FTU)	0.8	0.8	0.9	0.8	0.2	0.5	0.5	0.5	0.5	0.2
Colour Apparent (HZU)	4.8	4.1	4.1	4.1	0.1<W	0.7<T	0.7<T	0.7<T	0.7<T	0.1<W

<W - below detection limit

CRO - calculated result only

<T - this low measurement is tentative

SUPPORT CHEMISTRY FOR DIOXIN SAMPLING

Location: Niagara Falls

Date: July 12, 1983

Parameter/ Concentration	Sample Description Raw AB-1	Raw AB-2	Raw AB-3	Raw AB-4	Raw AB-FB	Treated CD-1	Treated CD-2	Treated CD-3	Treated CD-4	Treated CD-FB
Conductivity 25C	291	291	291	291	3.0	296	296	296	296	3.4
Hardness, Total (mg/L as $CaCO_3$)	120	119	121	122	0.5<W	121	124	123	125	0.5<W
Calcium, UNF Reactive (mg/L as C)	34	33	34	35	0.1<W	34	36	35	36	0.1<W
Magnesium UNF Reactive (mg/L as Mg)	8.6	8.7	8.6	8.6	0.05<W	0.5	8.4	8.4	8.5	0.05<W
Alkalinity Total (mg/L as $CaCO_3$)	97	97	97	98	3.4	90	91	92	92	3.2
pH	8.4	8.4	8.4	8.4	6.3	7.9	7.9	7.9	7.9	6.3
Residue Total (mg/L)	204(CRO)	189(CRO)	189(CRO)	189(CRO)	2.2<T	192(CRO)	192(CRO)	192(CRO)	192(CRO)	2.2<T
Turbidity (FTU)	1.0	1.0	1.0	1.0	0.2	0.3	0.3	0.3	0.3	0.2
Colour Apparent (HZU)	3.7	4.5	3.7	3.7	0.1<W	0.1<W	0.1<W	0.1<W	0.1<W	0.1<W

<W - below detection limit

CRO - **calculated result only**

<T - low measurement tentative

SUPPORT CHEMISTRY FOR DIOXIN SAMPLING

Location: Welland

Date: June 23, 1983

Parameter/ Concentration	Sample Description Raw AB-1	Raw AB-2	Raw AB-3	Raw AB-4	Treated CD-1	Treated CD-2	Treated CD-3	Treated CD-4	Chem 1 FB	Chem 2 FB	Chem 3 FB	Chem 4 FB
Conductivity 25C	316	315	315	316	322	323	323	323	4.1	4.2	4.3	4.3
Hardness, Total (mg/L as $CaCO_3$)	126	128	128	129	130	131	132	132	<0.5	<0.5	<0.5	<0.5
Calcium, UNF Reactive (mg/L as C)	35	36	36	37	37	37	38	38	<0.1	<0.1	<0.1	<0.1
Magnesium UNF Reactive (mg/L as Mg)	9.0	9.0	9.0	9.1	9.1	9.1	9.7	9.2	<0.05	<0.05	<0.05	<0.05
Alkalinity Total (mg/L as $CaCO_3$)	106	104	104	104	97	93	96	94	3.8	3.0	3.8	3.0
pH	8.4	8.4	8.4	8.4	7.7	7.7	7.7	7.7	6.6	6.6	6.6	6.4
Residue Total (mg/L)	192	198	185	193	208	207	207	207	5.0	4.2	3.8	4.2
Turbidity (FTU)	4.0	3.9	4.0	4.0	0.3	0.3	0.2	0.3	0.1	0.1	0.2	0.1
Colour Apparent (HZU)	8.9	10.1	8.9	8.9	1.5	1.5	1.5	1.5	<0.1	<0.1	<0.1	<0.1